Iowa Science Teachers Journal

Volume 21 | Number 3 Article 2

1984

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WRITING AND ELEMENTARY SCIENCE: A WINNING COMBINATION

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Most educators today believe that writing has a significant place in the curriculum. More importantly, many teachers agree that writing instruction should be a school-wide effort. In one study, 80 percent of the English teachers, 60 percent of the social studies teachers and 60 percent of the science teachers agreed that it was a responsibility that should be shared by both English and content area teachers (Tighe and Koziol, 1982).

The term "writing instruction" to most teachers means guiding student development of clear, conventional, credible written expression that communicates to an audience. This kind of writing, found in reports, term papers, proposals and memos, James Britton (1975) has called *transactional writing.* Clearly, it is important that students be made aware that good writing is valued in all subject areas and in all walks of life (Martin and D'Arcy, 1975).

A few teachers would like to broaden writing experiences to include the exploration and manipulation of language as art in imaginative fiction, poetry, drama and essays. This Britton (1975) labeled *poetic writing.*

Yet a third type of writing is known as *expressive writing.* The purpose of this kind of writing is not to communicate with others. Instead, it is done to let the writer find out what he or she thinks, feels and knows. It is aconventional, introspective and informal as the writer explores, speculates, searches and forms associations. This kind of writing may, after further drafts, result in transactional writing, but it often has as its only goal, decision making, problem solving, and understanding (Britton, 1975).

The role of expressive writing in the learning process has received little attention in the typical curriculum. One reason for the lack of emphasis may be that more needs to be learned about writing as a means by which students can contend with new information, discover relationships and clarify new ideas (Lehr, 1980). In an effort to address these needs, this study was conducted to find out if expressive writing used in a hands-on inquiry science class would improve both students' writing and their science learning.

The Importance of Writing in Science

Science should be a strong component of the school curriculum. In many schools, science study stops as soon as the scheduled time ends. It is usually allotted less time in a day than mathematics, social studies or language arts. Kay Reid (1977) said that combining science and writing is an easy enjoyable way to extend science concepts with students. An excellent way to teach science is to correlate it with writing, and an excellent way to make writing vital is to correlate it with science instruction.

When science is taught as a process, students explore the possible solutions to a given problem. This requires observing, thinking and investigating. Yet this process needs to be articulated through both speech and writing (Colby, 1975).

Students in a science class should first experience an activity, next discuss the experience, and then write about it. Together, these activities will help them to understand the concept. By verbalizing the experience, children will express their thoughts and ideas. Those aspects which are difficult to understand will become clearer.

According to Piaget, learning can occur only after assimilation has taken place. Assimilation may take place through talking, but writing has a number of advantages which talking does not. When writing, there is time for reflection, freedom from interruption, the possibility of holding ideas together long enough to see the links and forge new understandings (Macrorie, 1979).

Thus, writing is an act of making meaning. It is inextricably bound up with learning in the arts and sciences (Maimon, 1981).

In addition to its benefits to the students, writing can be used to diagnose problems arising from instruction and provide a post-teaching assessment of the students' abilities to apply what they have learned (Applebee, 1977).

Not only will the use of writing in science give students an opportunity to learn more science; it will also improve their writing abilities. Children improve their writing when writing is experience based (Haley, 1981). In a hands-on science class, children first experience, then write. This writing invites children to express thoughts in their own words, thus enabling them to use language as a means of discovering, experiencing, and controlling their own sense of the world.

Further data suggests that children studying science units interrelated with other subjects, including writing, are more open-minded, work better on reports and creative writing, and develop a positive attitude toward learning (Maimon, 1981).

Various types of transactional writing in the field of science can be found in most science classrooms: "Science writing" addresses the general public; its degrees of difficulty and less specialized vocabulary make it easier to read. "Technical writing" is narrow, factual, and nonfictional. "Scientific writing" is specialized and is directed to specialists. Using these as models, teachers can help future scientists and engineers to write effectively and well. Scientists who can communicate their ideas in writing advance more rapidly (Koeller, 1982). According to Britton, (1975), expressive writing can lead to effective transactional and poetic writing; hence, the use of expressive writing should lead to effective science writing in the future.

A required writing skill in science is exposition (Koeller, 1982). Expressive writing is an important prerequisite to exposition, a form of transactional writing (Britton, 1975). The three components of writing in science are: 1) the personal identification children have with their writing; (2) growth in fluency; and 3) clarity in explaining and describing information. The expressive voice precedes the child's ability to write objectively and scientifically (Koeller, 1982).

The science teacher can discuss the need for clarity in a report with more authenticity than can the English teacher, for science teachers can supply the details of the method and style of writing expected in their field. As students work on clarity, written composition skills are reinforced (Watson, 1983). Students learn that there can be some connection between what happens in science and English classes (Maimon, 1981).

In a study designed to discover if writing aids learning, a summer school science class wrote about environmental problems and laboratory activities to find out if writing would improve reading scores as well as writing scores. The researchers established a month's growth as their criterion for success in reading. Pretest and posttest forms of a standardized reading test were administered. Fifty-eight percent of the students reached the criterion on literal comprehension and 54 percent on inferential comprehension.

Improvement in writing was also measured. The researchers gave a pretest and posttest and set a criterion of 20 based on the Writing Samples Characteristics (WSC) described by the New York Department of Education. Thirty-seven percent of the 117 students taking part reached the criterion on the pretest and 77 percent reached it on the posttest (Chapline, 1979).

In summary, many authors believe that writing needs to be taught in all parts of the curriculum. Much writing assigned in schools is isolated from the learning process. When writing was integrated into a summer science workshop, students' reading and writing scores improved. This investigation, performed by the author, provides information that should be useful to elementary teachers who are interested in integrating writing into their science classes.

Research Design

The subjects for the study were 49 fifth-grade students enrolled in a kindergarten through fifth-grade elementary school. The study utilized a two-group, pretest/posttest research design. The students were randomly assigned to the classes. To establish the quality of the groups, both classes were given a pretest on attitudes, writing, and hands-on test on electricity.

For six weeks, both classes were taught the Elementary Science Study (ESS) unit "Batteries and Bulbs." Lessons were taught by one teacher, using the hands-on, inquiry method described by the ESS authors. The difference in treatment took place at the end of each lesson. One group of students was asked to use expressive writing in personal journals to describe what they had observed, identify the problems that they had encountered, ask any questions they still had, and summarize what they learned. They were also asked to express any feelings or concerns they had about the lesson. The student journals were turned in to the teacher. The teacher read and responded to the writing in a positive way using questions to clarify areas that were unclear. When the journals were returned to the students, they were asked to read and respond to the teacher's remarks and questions.

The second group was assigned worksheets instead of journal writing at the end of each lesson. The worksheets were written as a review of the lesson, but students had the option of "trying out," with their equipment, anything they did not understand. Completed worksheets were turned in and corrected by the teacher. After the worksheets were returned, the students made corrections and returned them to the teacher before proceeding with the next lesson.

At the conclusion of the unit, students from both groups were given a posttest that included the same type of hands-on test used at the beginning. A short answer, completion test and picture test that tested for vocabulary and concepts covered in the unit was also administered.

The students were also given a posttest on writing. The tests were based on observations made in a hands-on, inquiry type of activity just as the class lessons were. The literature and research indicate that students of this age need to use expressive writing to gain fluency and coherence. These are two skills that are part of the language curriculum, but no effort was made during the time of the research to work on fluency and coherence elsewhere in the curriculum.

Results

For each of the tests used in this study, the pretest results were compared to find out if differences between the experimental and control groups existed before the experiment started. Posttest scores were compared to determine if the difference existed after the treatment. A correlated t-test was calculated to determine whether the groups differed on subtests scores. The t-test was also used to determine if a significant growth was evident at the conclusion of the experiments. Because of the length of this report, only two data comparisons will be discussed.

The mystery box pretest was a hands-on activity requiring the students to make a circuit tester. Since the students were unable to make the tester prior to the lessons, they had no scores on the pretest, and there were no significant differences identified between the groups prior to the treatment. After treatment, both groups were given the hands-on posttest consisting of the same mystery boxes used on the pretest. The students were now able to make the tester and complete the test. The results of the posttest are shown in Table 1. Significant differences were found on the mystery box posttest. The data supports the hypothesis that expressive writing is one means to help obtain higher level thinking skills in an elementary science classroom.

Table 1
A comparison of the posttest results of the expressive writing group (1) and the worksheet group (2) using mystery boxes

	N	$\overline{X}$	SD	df	t
Group 1	25	10.52	2.95	47	2.52*
Group 2	24	8.33	2.99		

*Significant difference at .05 level.

The students in the expressive writing group also made significant growth in writing during the treatment period. Table 2 shows the results of the posttest on writing. These results agree with Weiss (1981) who found that using writing in science would help students learn to write, and with Haley (1981) who said that experience-based writing helps children learn to write.

Table 2
A comparison between the expressive writing group (1) and the worksheet group (2) on the writing posttest using the t-test

	N	$\overline{X}$	SD	df	t
Group 1	25	2.32	.79	47	2.94*
Group 2	24	1.79	.82		

*A significant difference at the .01 level.

Conclusions

Expressive writing had the greatest effect on growth in writing. However, there were also significant differences in science growth in two of the three tests given. In both posttests for science concepts, the expressive writing group scored significantly higher.

This study was limited in several areas: 1) the population treated was students enrolled at only one grade level; 2) the number of students was small; 3) only one teacher was involved in the study and her biases could have affected the outcome; 4) the tests used for science concepts and writing were designed by the researcher using educators as judges, but the tests have not been tested by other researchers.

The use of expressive writing as a learning tool differs from transactional writing (writing to inform, instruct or persuade) most frequently used in schools today. Both forms of writing should be tested and compared in the classroom. Most of the reported research has been done at the college level. If writing is developmental and begins at the elementary level as the "experts" have indicated, then more research at that level needs to be done, especially in regard to the use of expressive writing to enhance learning.

This study points to a need for more research in the area of writing in the content areas. Educators must determine how science and writing can best be taught to facilitate transfer of learning. If writing is to become a part of content area classes, its value as a learning tool should be investigated more fully. Most teachers will add writing to the curriculum if its value can be proven.

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